

## RESIDENTIAL ACM APPENDIX RI

### **Appendix RI – Procedures for Verifying the Presence of a Thermostatic Expansion Valve or High Energy Efficiency Ratio Equipment**

#### **RI-1 Purpose and Scope**

The purpose of these procedures is to verify that residential space cooling systems and heat pumps have the required components to achieve the energy efficiency claimed in the compliance documents. The procedures only apply when a TXV is specified for split system equipment or an EER higher than the default is claimed. For dwelling units with multiple systems, the procedures shall be applied to each system separately.

The installer shall certify to the builder, building official and HERS rater that he/she has installed all the correct components.

The reference method algorithms adjust (improve) the efficiency of air conditioners and heat pumps when field verification indicates the specified components are installed. Table RI1 summarizes the algorithms that are affected.

*Table RI-1 – SUMMARY OF FIELD VERIFICATION*

Field Verification Check	Variables and Equation Reference	Description	Standard Design Value	Proposed Design	
				Default Value	Procedure
Diagnostic					
Presence of a TXV	$F_{TXV}$ (Eq. R4-40 <del>F4-42</del> and <del>R4-41</del> <del>F4-43</del> )	$F_{TXV}$ takes on a value of 0.96 when the system has a verified TXV or has been diagnostically tested for the correct refrigerant charge. Otherwise, $F_{TXV}$ has a value of 0.90.	Split systems are assumed to have refrigerant charge testing or a TXV, when required by Package D.	No TXV or refrigerant charge testing.	<del>RI-2</del>
Presence of a matched High Efficiency Compressor Unit, Evaporator Coil, Refrigerant Metering Device, and (where specified) Air Handling Unit and/or Time Delay Relay.	EER	The EER is the Energy Efficiency Ratio at 95 F outdoors specified according to ARI procedures for the matched combination	Systems are assumed to have the default EER based on SEER, see ACM Equation 4.44.	Default EER	RI-3 and RI-4

#### **RI-2 TXV Verification Procedure**

The procedure shall consist of visual verification that the TXV is installed on the system.

#### **RI-3 Time Delay Relay Verification Procedure**

When a high EER system specification includes a time delay relay, the installation of the time delay relay shall be verified.

The procedure shall be:

- 1) Turn the thermostat down until the compressor and indoor fan are both running.
- 2) Turn the thermostat up so the compressor stops running.
- 3) Verify that the indoor fan continues to run for at least 30 seconds.

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**RI-4 Matched Equipment Procedure**

When installation of specific matched equipment is necessary to achieve a high EER, installation of the specific equipment shall be verified.

The procedure shall consist of visual verification of installation of the following equipment and confirmation that the installed equipment matches the equipment required to achieve the high EER rating:

- 1) The specified labeled make and model number of the outdoor unit.
- 2) The specified labeled make and model number of the inside coil.
- 3) The specified labeled make and model of the furnace or air handler when a specific furnace or air handler is necessary to achieve the high EER rating.
- 4) The specified metering device when a specific refrigerant metering device (such as a TXV or an EXV) is necessary to achieve the high efficiency rating.

# ~~APPENDIX I~~

## **Appendix I: Interior Mass Capacity**

The *Interior Mass Capacity (IMC)* of a material is calculated by multiplying its *Area* times its *Unit Interior Mass Capacity (UIMC)* using Equation I-1. Tables 3-2a, 3-2b and 3-3 list the UIMCs for a number of thermal mass materials. This method allows for multiple mass types in both raised-floor and slab-on-grade construction.

The *Interior Mass Capacity* for the *Standard Design* shall be determined as 20 percent of the *Proposed Design's* conditioned slab floor as 3.5 inch thick exposed slab (UIMC=4.6), 80% of the conditioned slab as 3.5 inch thick rug-covered slab (UIMC=1.8), and 5% of the *Proposed Design's* conditioned nonslab floor area as exposed 2 inch thick concrete (UIMC=2.5). If the user does not specify a high mass design, the *Interior Mass Capacity* of the *Proposed Design* shall be the same as for the *Standard Design*. If the user specifies a high mass design with an *Interior Mass Capacity* greater than the high mass threshold, the user is allowed to model the mass specified in the *Proposed Design*. The high mass threshold *Interior Mass Capacity* is determined as 30% of the conditioned floor area as exposed slab (UIMC=4.6), 70% of the conditioned slab floor area as rug-covered slab (UIMC=1.8), and 15% of the conditioned nonslab floor area as 2 inch thick concrete (UIMC=2.5).

### ***EQUATION NO. I-1***

#### ***CALCULATION OF INTERIOR MASS CAPACITY***

$$IMC = [(A_1 \times UIMC_1) + (A_2 \times UIMC_2) \dots + (A_n \times UIMC_n)]$$

Where,

—  $A_n$  = Area of mass material  $n$ , and

—  $UIMC_n$  = Unit Interior Mass Capacity of mass material  $n$

Based on the UIMCs given above:

$$IMC_{threshold} = 2.64 \times CSA + 0.375 \times (CFA - CSA)$$

Where:

—  $CSA$  = Conditioned Slab floor Area

—  $CFA$  = total Conditioned Floor Area

**Table 3-2a: Interior Mass UIMC Values:****Interior Mass<sup>11</sup> – Surfaces Exposed on One Side<sup>13</sup>**

			Unit
			Interior
			Mass
Material	Surface Condition	Thickness (inches)	Mass Capacity
Concrete	Exposed <sup>1</sup>	2.00	3.6
		3.50	4.6
		6.00	5.1
	Covered <sup>2</sup>	2.00	1.6
		3.50	1.8
		6.00	1.9
Lightweight Concrete <sup>a</sup>	Exposed	0.75	1.0
		1.00	1.4
		1.50	2.0
		2.00	2.5
	Covered	0.75	0.9
		1.00	1.0
		1.50	1.2
		2.00	1.4
Solid Wood <sup>a</sup>	Exposed	1.50	1.2
		3.00	1.6
Tile <sup>3,a</sup>	Exposed	0.50	0.8
		1.00	1.7
		1.50	2.4
		2.00	3.0

Masonry <sup>4,9</sup>	Exposed	1.00	2.0
		2.00	2.7
		4.00	4.2
Adobe <sup>9</sup>	Exposed	4.00	3.8
		6.00	3.9
		8.00	3.9
Framed Wall	0.50" Gypsum	na	0.0
	0.63" Gypsum	na	0.1
	1.00" Gypsum	na	0.5
	0.88" Stucco	na	1.1
Masonry Infill <sup>z</sup>	0.50" Gypsum	3.50	1.3

Table 3-2 continued on next page.

**Table 3-2b: Interior Mass UIMC Values:**

**Interior Mass<sup>11</sup> - Surfaces Exposed on Two Sides<sup>5,13</sup>**

		Unit	
		Mass	Interior
		Thickness	Mass
Material	Surface Condition	(inches)	Capacity
Partial Grout Masonry <sup>4</sup>	Exposed <sup>+</sup>	4.00	6.9
		6.00	7.4
		8.00	7.4
Solid Grout Masonry <sup>4,6</sup>	Exposed	4.00	8.3
		6.00	9.2
		8.00	9.6
Adobe	Exposed	4.00	7.6
		12.00	7.8
		16.00	7.6

Solid Wood/	Exposed	3.00	3.3
Logs		4.00	3.3
		6.00	3.3
		8.00	3.3
Framed Wall	0.50" Gypsum	na	0.0
	0.63" Gypsum	na	0.2
	1.00" Gypsum	na	0.9
	0.88" Stucco	na	2.1
Masonry Infill <sup>z</sup>	0.50" Gypsum	3.50	2.6
Notes follow Table 3-3.			

**Table 3-3: Exterior Wall Mass UIMC Values and Exterior Mass Factors<sup>13</sup>**

Material	Surface Condition	Mass		Unit	
		Thickness (inches)	Wall U-value	Interior Mass Capacity	Exterior <sup>8</sup> Mass Factor
Partial Grout Masonry <sup>4</sup>	Exposed <sup>1</sup>	4.00	0.68	0.9	1.1
			0.58	1.0	1.0
		6.00	0.54	1.3	1.3
			0.44	1.5	1.1
		8.00	0.49	1.5	1.3
			0.38	1.7	1.2
	Furred <sup>10</sup>	4.00	0.40	0.5	0.9
			0.30	0.5	0.7
			0.20	0.5	0.5
			0.10	0.5	0.3
			0.08	0.5	0.2
		6.00	0.40	0.9	1.2
			0.30	0.6	1.0
			0.20	0.5	0.7
			0.10	0.5	0.4
			0.08	0.5	0.3
		8.00	0.30	0.8	1.0
			0.20	0.5	0.7
			0.10	0.5	0.4
			0.08	0.5	0.3
Solid Grout Masonry <sup>4,6</sup>	Exposed	4.00	0.79	1.0	1.4
		6.00	0.68	1.5	1.9
		8.00	0.62	1.8	2.1
		Furred <sup>10</sup>	4.00	0.5	1.0

	0.30	0.5	0.8
	0.20	0.5	0.6
	0.10	0.5	0.3
	0.08	0.5	0.3
6.00	0.40	0.7	1.4
	0.30	0.5	1.1
	0.20	0.5	0.7
	0.10	0.5	0.4
	0.08	0.5	0.3
8.00	0.40	0.8	1.5
	0.30	0.6	1.2
	0.20	0.5	0.8
	0.10	0.5	0.4
	0.08	0.5	0.3
Table 3-3 continued on next page			

**Table 3-3: Exterior Wall Mass UIMC Values and Exterior Mass Factors<sup>13</sup>**

Material	Surface Condition	Mass Thickness	Wall	Unit Interior	Exterior <sup>9</sup>
		(inches)	U-value	Mass Capacity	Mass Factor
Solid Wood/ Logs	Exposed <sup>1</sup>	3.00	0.22	0.7	0.5
		4.00	0.17	0.9	0.6
		6.00	0.12	1.1	0.6
		8.00	0.093	1.2	0.4
		10.00	0.075	1.3	0.3
		12.00	0.063	1.3	0.3
Wood Cavity Wall <sup>12</sup>	Exposed	3.00 <sup>12</sup>	0.11	1.1	0.5
			0.065	1.3	0.3
			0.045	1.4	0.2
Adobe	Exposed	8.00	0.35	2.1	1.5
		16.00	0.21	2.8	0.8
		24.00	0.15	3.1	0.5
Masonry	Framed Wall	4.00	0.10	na	0.3
Veneer <sup>4</sup>			0.08	na	0.3
			0.06	na	0.2
Adobe	Framed Wall	4.00	0.10	na	0.4
Veneer			0.08	na	0.3
			0.06	na	0.2

**Notes For Tables 3-2 and 3-3:**

1. "Exposed" means that the mass is directly exposed to room air or covered with a conductive material such as ceramic tile.
2. "Covered" includes carpet, cabinets, closets or walls.
3. The indicated thickness includes both the tile and the mortar bed, when applicable.
4. Masonry includes brick, stone, concrete masonry units, hollow clay tile and other masonry.

- ~~5. The unit interior mass capacity for surfaces exposed on two sides is based on the area of one side only.~~
- ~~6. "Solid Grout Masonry" means that all the cells of the masonry units are filled with grout.~~
- ~~7. The indicated thickness for masonry infill is for the masonry material itself.~~
- ~~8. Use the Exterior Mass value for calculating Exterior Wall Mass.~~
- ~~9. Mass located inside exterior walls or ceilings may be considered interior mass (exposed one side) when it is insulated on the exterior with at least R-11 insulation, or a total resistance of R-9 including framing effects.~~
- ~~10. "Furred" means that 0.50-inch gypsum board is placed on the inside of the mass wall separated from the mass with insulation or an air space.~~
- ~~11. When mass types are layered, e.g. tile over slab-on-grade or lightweight concrete floor, only the mass type with the greatest interior mass capacity may be accounted for, based on the total thickness of both layers.~~
- ~~12. This wall consists of 3 inches of wood on each side of a cavity. The cavity may be insulated as indicated by the U-value column.~~
- ~~13. Values based on properties of materials listed in 1993 ASHRAE Handbook of Fundamentals.~~